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CIRCULATION OF THE *PUBLICATIONS* OF THE LICK OBSERVATORY.

In November, 1888, a copy of volume I of the *Publications* of the Lick Observatory was sent to a library in Boston. A letter lately received states that during the past year it has been taken out by eighty-seven persons, and that nineteen others are registered to receive it in their turn! If the whole edition is read as faithfully, the work will have been useful. E. S. H.

ACCESSIONS TO THE LIBRARY.

Dr. GEORGE F. BECKER, of the U. S. Geological Survey, has done the Observatory a great service by depositing in its library the following volumes from his private collections:

CRELLE: *Journal für die reine und angewandte Mathematik*; Vols. 1 (1826) to 15, inclusive; parts of 16 and 18; Vols. 20 to 68, inclusive. [The Observatory set begins with Vol. 100.]

GILBERT: *Annalen der Physik*; complete, 1799–1824; Vols. 1 to 76, inclusive, with index.

THOMSON & TAIT: *Handbuch der Theoretischen Physik*; Vol. 1; two parts.

LAGRANGE: *Œuvres de Lagrange*; [Government edition of 1867]; Vols. I, II.

LAPLACE: *Œuvres de Laplace*; [Government edition of 1843]; Vols. I, II, III, IV, V, VI, VII (bound in 4.)

These books are to remain on our shelves as a permanent loan, until recalled by their owner. The list is given here in order that members of the Society may know of the existence of these works in one of the libraries of the Pacific Coast. Some of them are also to be found in the University Library, Berkeley. E. S. H.

PROBABLE RETURN OF LEXELL'S COMET.

The news of a remarkable and extremely important discovery in cometary astronomy, made by Mr. S. C. CHANDLER—so well known as a mathematician and astronomer—has just been received. Mr. CHANDLER has just completed a preliminary examination into certain peculiarities of the orbit of the comet discovered in July last by Mr. BROOKS, and which is still under observation.

This comet has been found to revolve in an elliptical orbit about the sun in seven years. It has attracted particular attention through

the discovery, at the Lick Observatory, of the remarkable companion comets that attend it in its journey through space.

Before speaking of Mr. CHANDLER'S discovery, it will be necessary for us to go back, in time, over one hundred years, to the date of the discovery of LEXELL'S comet, in 1770. Upon the computation of the orbit of this comet, LEXELL found it to be revolving about the sun in a period of five and one-half years. This was considered remarkable, for the comet was visible to the naked eye, and, therefore, ought to have been seen at some of its former returns. But it had never been seen before—nor has it indeed, been seen since.

LEXELL found that the *aphelion* of this comet was very close to *Jupiter*, and that it had made a very close approach to that planet in 1767. He also found that, previous to 1767, the comet had moved in an orbit whose *perihelion* was near *Jupiter*, and its distance, therefore, so great that it could not be seen from the earth. At this near approach to *Jupiter* in 1767, the planet's attraction on the comet was three times as great as that of the sun, and the comet, therefore, remained in the vicinity of *Jupiter* for many months, its orbit becoming completely changed, so that when it finally was freed from the overpowering influence of the planet, it was thrown into a much smaller orbit, in which it would make a revolution in five and one-half years. In this small orbit it approached very near the earth, and was visible to the naked eye. At its nearest approach to the earth in 1770, it was less than one and one-half million miles distant. So close was this approach, indeed, that LAPLACE computed that if the comet had had any considerable mass, it would have seriously disturbed the motion of the earth in its orbit, and if the mass had been equal to that of the earth, it would have shortened the length of our year by something like three hours. From the fact that no sensible disturbance was experienced from the proximity of the comet, LAPLACE concluded that its mass was certainly less than the one-three-thousandth part of the mass of the earth, or less than one-fortieth of the mass of our moon. It was, doubtless, vastly smaller than that.

In 1779, the comet made a still closer approach to *Jupiter*, and at that time the attraction of the planet on the comet was over two hundred times as great as that of the sun, and the orbit was again changed, the perihelion distance becoming so great that the comet could not be seen from the earth. BURCKHARDT, who verified LEXELL'S calculations, found that before the comet came under the influence of *Jupiter* in 1779, its perihelion distance was probably 5.08, while that of the orbit of 1770 was 0.67, and after the disturbance,

through its proximity to *Jupiter*, in 1779, its perihelion distance probably became 3.33, the distance of the earth from the sun being assumed unity. This body, because of its never having been seen since 1770, has been called the *lost comet*, and it has stood as the most remarkable example that we have of planetary influence in disturbing the motions of comets.

We will now return to Mr. CHANDLER'S investigations. He found that BROOKS' comet must have made a remarkably close approach to *Jupiter* in 1886, and that the attraction of the planet then threw the comet into its present orbit, whatever may have been its path previous to that time. This led him to suspect the identity of this comet with the famous LEXELL comet of 1770, and he, therefore, attacked the problem with renewed interest. He found that, previous to the encounter with *Jupiter* in 1886, the BROOKS' comet was moving in an entirely different orbit from that in which it now moves. The periodic time in this former orbit was twenty-seven years, and its aphelion lay outside of *Saturn's* orbit and the perihelion where the present aphelion is.

Mr. CHANDLER, in speaking of the motion of the comet before the disturbance of 1886, says: "Several months before reaching its perihelion, it passed, near the beginning of 1886, into the sphere of *Jupiter's* attraction, and was deflected into a hyperbolic path about the planet, remaining for more than eight months under its control—the disturbing action of the sun during most of that interval being insignificant. The eccentricity of the hyperbola was but slightly in excess of unity, so that the comet narrowly escaped being drawn into a closed orbit as a satellite of *Jupiter*. A slight diminution of the initial velocity relatively to *Jupiter* would have thrown it into an elliptic orbit about the planet."

Mr. CHANDLER also says that, at the close approach to *Jupiter* in 1886, the comet passed a little outside of the orbit of the third satellite, and that it is not impossible that the unequal attraction of *Jupiter* and his satellite system may have caused a disruption of the cometary matter such as would produce the companions that have been discovered attending it, and that these small bodies may owe their existence to the opposing attractions of *Jupiter* and his satellites, in 1886.

What have been the changes that this comet has undergone since 1770 through the repeated disturbances by *Jupiter* it is not possible to tell at present. However, the comet is now, at least, free from the disturbing action of that planet; but this will not continue indefi-

nately, as it will again encounter *Jupiter* in 1921, under nearly the same conditions as in 1886, and its orbit will again suffer a complete change, the comet, perhaps, once more being thrown into an orbit whose perihelion distance will be so great that it will again be lost to observers, with, perhaps, as long a period of invisibility as it has suffered since 1770, to reappear again some time in the future, through the attractions of *Jupiter*, if, indeed, it can maintain its integrity as a single body under the enormous stresses to which it has been, and may again be, subjected. However this may be, there is very little doubt that Mr. CHANDLER has been the first to point out one of the most remarkable of all cometary histories, and that his discovery is of the first importance.

E. E. BARNARD.

Mt. HAMILTON, December 5, 1889.

# OCCULTATIONS OF STARS AT THE DARK LIMB OF THE MOON, OBSERVED WITH THE TWELVE-INCH EQUATORIAL.

BY E. E. BARNARD.

1889.	L. O. M. T.	STAR.	R. A.	DEC.	REMARKS.
	<i>h. m. s.</i>		<i>h. m. s.</i>	<i>° ' "</i>	
Oct. 28	6 30 10.4	B. A. C. 6304.	18 24 23	- 24 13	Good. Instantaneous.
" 28	6 42 09.4	Anon. 9 <sup>m</sup> .....	18 24 43	- 24 09	Good.
" 28	6 46 39.6	W. M. Z. 170.	18 24 55	- 24 13	Good. Instantaneous.
" 28	6 53 22.6	24 Sagittarii*.	18 25 02	- 24 08	Good. Instantaneous.
" 28	7 10 27.8	25 " ..	18 25 41	- 24 20	Good. Instantaneous.
" 30	6 58 23.7	S D. - 22°.5485	20 29 10	- 22 20	{ Faded slightly 15 before disappearing; then in- stantly disappeared. Star faint.
" 30	7 07 36.7	S D. - 22°.5489	20 30 17	- 22 15	
" 30	8 16 55.4	S D. - 22°.5498	20 32 05	- 22 08	No remarks.
" 30	8 18 18.2	S D. - 22°.5495	20 31 51	- 22 05	No remarks.
Nov. 25	6 26 19.7	Y. 8364.....	19 06 43	- 24 25	Good. Sudden.
" 25	6 39 58.3	W. T. Z. 57 ..	19 07 07	- 24 20	Good. Sudden.
Dec. 29	6 07 52.9	DM. + 2°.205	1 17 35	+ 2 17	Good. Instantaneous.
" 29	6 12 47.9	DM. + 2°.207	1 18 12	+ 2 12	Good. Sudden

\* The reappearance of this star was at 7h. 57m. 19s.6; late 1s. or 2s.; limb boiling; star faint. Cloudy weather has interfered with the observations.

NOTE.—The above observations, together with those at the new moons of August and September (see *Publ. A. S. P.*, vol. 1, p. 70), have been made here, in the hope that they may be useful to the officers of the U. S. Coast and Geodetic Survey now engaged in determination of longitudes in Alaska.

E. S. H.